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Article (Published Version)

Sovacool, Benjamin K, Kester, Johannes, Noel, Lance and Zarazua de Rubens, Gerardo (2019) Income, political affiliation, urbanism and geography in stated preferences for electric vehicles (EVs) and vehicle-to-grid (V2G) technologies in Northern Europe. *Journal of Transport Geography*, 78. pp. 214-229. ISSN 0966-6923

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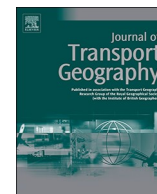
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Income, political affiliation, urbanism and geography in stated preferences for electric vehicles (EVs) and vehicle-to-grid (V2G) technologies in Northern Europe

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ARTICLE INFO

Keywords:

Sustainability transitions
Low-carbon transport
Electric vehicle adoption
Vehicle-to-grid
Electric mobility

ABSTRACT

Despite a potentially revolutionary shift towards electric mobility in the passenger vehicle market, the academic and policymaking communities remain wedded to a techno-economic paradigm that may not fully appreciate deeper social and geographic elements of a transition to electric vehicles. In this paper, based primarily on bivariate statistical analysis as well as a hierarchical regression analysis of a survey distributed to > 5000 respondents across Denmark, Finland, Iceland, Norway, and Sweden, we analyze how perceptions and attitudes towards electric vehicles and vehicle-to-grid technologies differ by income, political affiliation, and geography. Although our findings confirm EV ownership and mobility patterns in general are related to income—those with higher incomes both own more EVs and drive more generally—they also confirm that interest in EVs is not so strongly related. Lower income groups seem to ask less from their cars, thus potentially opening up a market for cheaper low-range alternates. Political orientation is correlated to car and EV ownership, with those on the “left” more interested yet those on the “right” more able and willing to buy expensive cars. Moreover, we see variation in preferences across urban and rural subcategories, and our findings strongly suggest that EVs need not be promoted only for city or suburban areas. When controlling for variables, a multilevel regression analysis does not change the overall thrust of these associations.

1. Introduction

Rapid and deep reductions in greenhouse gas emission are needed to avoid dangerous climate change (Geels et al., 2017). To provide a reasonable (66%) chance of limiting global temperature increases to below 2 °C, global energy-related carbon emissions must peak by 2020 and fall by > 70% in the next 35 years (IEA/IRENA, 2017). This implies a tripling of the annual rate of energy efficiency improvement, retrofitting the entire building stock, generating 95% of electricity from low-carbon sources by 2050 and shifting almost entirely towards battery electric vehicles, or EVs. The International Energy Agency (IEA, 2017a) even projects in its most recent World Energy Outlook, under the “Sustainable Development Scenario,” that 875 million EVs will need to be adopted by 2040. Configuring EVs as part of a vehicle-to-grid (V2G) system, where vehicles can not only consume power but also store or supply energy or energy services back to the grid, could accelerate these trends. Mohaddes and Sweatman (2016) project that another 50 million

vehicles globally could offer active V2G services by 2030. Such adoption of EVs could not only bring strong positive abatement of greenhouse gases, but also displace air pollution, emissions of particulate matter and other hazardous pollutants from road traffic (World Health Organization, 2018).

However, to date low-carbon transitions have less success in passenger transport (compared to other sectors such as electricity, heat, and buildings), as the petroleum-fueled automobility regime is still deeply entrenched or “locked in” in most Western countries (Steinheilber et al., 2013; Geels et al., 2012; Urry, 2004; Cowan and Hulten, 1996; Johan et al., 1994). Some innovations, such as hybrid EVs (HEV), plug-in hybrids (PHEV), and battery EVs, hold promise. In 2016, > 2 million PHEVs and EVs were on the road globally, and they exceeded 1% of new vehicle sales in five countries (Sweden, Denmark, France, China, UK) and 5% in two more (Norway and the Netherlands) (IEA, 2017b). In 2017, Volvo announced that it will cease production of purely conventional vehicles by 2019, followed by other manufacturers promising

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to promote EVs within a decade, including the Volkswagen Group, BMW Group, and Fiat-Chrysler. Moreover, cities such as London, the United Kingdom and Paris, France, also announced bans on conventional vehicles by 2040, and Oslo, Norway, plans to go “car free” in the inner city by the end of 2019.

Despite this potential shift towards electric mobility for passenger cars, the academic community often remains wedded to a techno-economic paradigm that may not fully appreciate the class, political, and spatial elements of a transition to electric vehicles. By class, we refer to income; by political orientation, a spectrum of affiliations commonly adopted across the Nordic region (Socialist/Green, Social Democrat, Christian Democrat/Conservative, and Liberal); and by geography, both country of origin as well as urban or rural location. For example, most techno-economic assessments of innovation or decarbonisation, especially integrated assessment models (IAMs) have a limited representation of the actors involved (mostly firms and consumers interacting via markets, which are shaped by exogenous policymakers) and overly simplistic models of their decision-making (rational, optimizing) (Stern et al., 2016; Hui, 2017). Secondly, IAMs often optimize on one dimension (cost), leading modelers to search for optimal or ‘first-best’ pathways, even if this includes technologies that are socially controversial or not yet technically or economically feasible (Anderson and Peters, 2016). The policy mechanisms literature also tends to be demographically and spatially neutral, assuming that a single fix—such as a carbon tax—will work across all markets. A case in point is a recent study proposing a “carbon law” that will guarantee that zero-emissions are reached. This model-based prescription focuses on policy, but not politics, culture, business, and social factors, thus avoiding many crucial real-world drivers (Rockstrom et al., 2017).

In this paper, we examine some of the deeper economic, political, and spatial factors involved with the adoption (and non-adoption) of one low-carbon form of mobility, electric vehicles. Based primarily on analysis of a survey distributed to a mix of > 5000 respondents across Denmark, Finland, Iceland, Norway, and Sweden, and supplemented with a comprehensive literature review, we analyze how perceptions and attitudes towards EVs and vehicle-to-grid differ by income, political affiliation, and geography. In doing so we hope to reveal the more complex dynamics behind how potential adopters in Denmark, Finland, Iceland, Norway, and Sweden consider and calculate various aspects of conventional mobility, electric mobility, and V2G.

Our paper therefore aims to make multiple contributions. Unlike a large body of studies looking at social or purely demographic factors such as gender, occupation, and household size, our study has a unique and explicit focus on issues of (a) income, classism, and equity, (b) politics and political identity, and (c) geographic space and urbanism. And, unlike studies investigating only EVs, we also include V2G, a technology just emerging in the Nordic region, and elsewhere, of which consumers have little to no previous knowledge.¹ Furthermore, our study has recent data, with a survey instrument distributed in early 2017, thereby reflecting perceptions of EVs as they existed recently, rather than many years ago. Our survey sample also includes self-stated actual users and adopters of EVs, those with direct experience of them, an explicit shortcoming noted in most EV research. Finally, we would emphasize the value of the comparative nature of our study (data

collected cross five countries) along with a large sample size (which we believe improves our validity) in the Nordic region, currently the third largest market for EVs in the world after China and the United States (IEA, 2017b).

2. Research design: a survey, data analysis, and a targeted literature review

This section describes our research design, including a survey, our data analysis, and our literature review.

2.1. A comparative Nordic survey

To collect data on the income, political, and spatial dimensions of electric mobility, our primary method was a structured questionnaire, a “survey,” consisting of three parts with 44 total questions. This included a choice experiment, reported on elsewhere by Noel et al. (2019a), as well as other dimensions such as gender, education, and age, reported on elsewhere by Sovacool et al. (2018). Here we exclusively report on the findings relating to income, politics and political identity, and geography and space.

The first part of the survey asked about the vehicle background and the existing mobility patterns of respondents, namely how often they drive, how far they drive daily on average, how much they are expecting to pay for a car, etc. The second part asked respondents what they valued most, or least, when they considered future purchases and design attributes such as acceleration, size, and safety. This part also included questions specifically about electric vehicles such as charging availability, range, and battery life, asking them to rate these features according to a five point Likert (1932) type scale of extremely unimportant/very uninterested to extremely important/very interested. The final part of the survey asked respondents for basic demographic information such as income, political affiliation, and environmental values. A complete copy of the survey is offered in the Supplementary Online Material (SOM).

Distribution of the survey was online and anonymous, a research design intended to minimize dishonesty and promote candor. For instance, psychological studies of survey design have found that the more impersonal the conditions, the more honest people will be. For eliciting truthful answers, internet surveys are better than phone surveys, which are better than in-person surveys, as “people will admit more if they are alone than if others are in the room with them” (Stephens-Davidowitz, 2017). Our survey was completed by a mix of 4322 random respondents, facilitated through the survey hosting firm Qualtrics, and 745 non-random respondents, facilitated through an online version distributed by the authors’ professional networks and during fieldwork in the respective countries. This puts the total respondent number at 5067 shown in Table 1 and this already excludes surveys that were incomplete or obviously false.

Undoubtedly, our research design has a number of limitations. First, we ended up combining the sample of randomized respondents with a purposeful sample to increase response rates from Iceland and in particular to include more respondents with direct experience of EVs. Indeed, in their review of the literature, Rezvani et al. (2015: 133) caution that a flaw many survey articles have is that they recruit “participants who have had no direct experience of EVs on which to base their responses” and are thus “psychologically distant from EVs,” limiting “the validity of inferences about adoption drawn from their responses.” Jensen et al. (2014, 2017) similarly argue that more EV research needs to involve users, consumers, or drivers with actual experience of EVs, to better reflect attitudes and intentions gained from direct experience. Second, we treat stated preferences as stable and fixed, soliciting them at a single point in time, whereas in reality they are flexible, fluid, and co-constructed over time, a limitation that could be offset by the “long panel” approach proposed by Jensen et al. (2014, 2017) in future research. Third, our approach may be prone to selection

¹ At the time we finished our survey in 2017, no real V2G services were offered in these countries, at least at a commercial scale. Nuvve had a small pilot project in Denmark (it has been extended to Bornholm, but at the time of the survey it was only Fredericksberg Forsyning). In Finland, the company Virta was considering integrating the possibility of V2G into their back-end software products, but not any applications. In Oslo, the Vulcan garage was under development, but that was smart charging with stationary batteries, not V2G. In late 2017 a pilot between Virta, Helen (utility in Helsinki) and Nissan was announced, but this again wasn’t at commercial scale. And, as of 2018, the Parker-Project (2018) highlights at least 50 V2G projects across 14 countries, but these are all still only at the pilot stage.

Table 1
Summary of survey distribution.

Country	Respondents (random)	Respondents (non-random)	Total
Denmark	953	185	1138
Finland	962	143	1105
Iceland	496	214	710
Norway	959	103	1062
Sweden	952	100	1052
Total	4322	745	5067

bias in that only those expressing a strong interest in the topic of electric mobility or V2G would potentially take the time to complete the survey.

Nonetheless, as Fig. 1 indicates, our combined sample shows a fair distribution across gender, age, political orientation, and education. Simultaneously, the combined sample of respondents shows considerable variance for occupation (more private sector participants than others), income (most respondents in middle ranges of household income), kilometers travelled (most fewer than 50 km a day), and car ownership (most own at least one car).

2.2. Bivariate and multivariate data analysis

The survey results were initially analyzed through descriptive bivariate statistical analysis and (when relevant) a variety of techniques including Pearson chi-square (χ^2), Spearman's rho (r_s) correlation tests, and K-Independent Kruskal-Wallis tests to highlight variance and associations between in-group distributions. Income (ordinal with 7 classes), political orientation (nominal with 6 classes), countries (nominal with 5 classes), and level of urbanization (nominal with 3 classes) are analyzed with Chi-Square to highlight potential associations between these variables and car ownership (no/yes), average KM's per day (ordinal with 6 classes), EV driving experience (not sure/no/yes), EV ownership (no/yes), EV interest of non-EV owners (ordinal Likert type: with 1 = very uninterested to 5 = very interested), and expected next car purchase price (ordinal with 6 classes). In turn, we draw on K-Independent Kruskal-Wallis tests (the nonparametric ANOVA alternative) to analyze these independent variables in relation to the questions about car preferences and EV preferences (all Likert type questions ranging from 1 = very unimportant to 5 very important).

For our data analysis, correlations are used to indicate strength of association between variables through correlation coefficients, which Cohen (1988) indicates are weak around 0.10, moderate around 0.30, and strong around 0.50. However, Hemphill (2003), in a metastudy on actual findings in psychology, a field known for its experimental work, finds that about one-third of all correlations fall under 0.20, one third of coefficients fall between 0.20 and 0.30 and only one third of studies find coefficients over 0.30. Moreover, Amrhein et al. (2019) and Wasserstein et al. (2019) both strongly argue that looking at “less significant” effect sizes can still reveal critically important associations. As the choice of a car is influenced by many different aspects, only some of them discussed here, we expect low but still meaningful correlations.

Admittedly, numerous studies deploy a range of other statistical approaches, such as multivariate analysis, cluster analysis, or stated choice experiments, to go “beyond” single demographic attributes and control for different variables. We do so only partly. On the one hand, this is due to the quality of the data gathered and the diverging conventions about how to handle nominal or ordinal data. We would argue that in this case and for this paper nonparametric tests offer valid methods of analysis, because of the categorical nature of the variables. Furthermore, our aim was explicitly to use bivariate statistical tests in an explorative and transparent manner to find clear associations and variances between the particular variables (e.g., income, politics, and space) and the variables on car use, EV experience, and vehicle preferences. In other words, to highlight those potential relationships that

sometimes get lost in larger models; often because the dependent variable is based on current EV adopters, not future potential sub-markets (Zarazua de Rubens, 2019). Lastly, rather than “back fit” the results around only the most interesting or significant findings (a process known as “p hacking” or “data-mining”), we instead present all data in both quantitative and qualitative (narrative) form. This has the advantage of not filtering data, and it can also be used by those seeking to develop more rigorous models or levels of data analysis.

Nonetheless, in order to observe the relative importance of geography, urbanization, income and political orientation, interaction effects do remain important. Hence, after we present the bivariate analysis, we present a short section with multivariate analysis to understand the relative effects and interaction between these variables and EV interest. This section of our paper utilizes a five model hierarchical regression analysis to control for the influence of gender and age, and then in subsequent models adds nationality, urbanization, political orientation and finally income orientations. Our model has no outliers (Std. Residual Min = −2.942, Std. Residual Max = 1.749), no multicollinearity (Tolerance between 0.28 and 0.95; VIF between 1.04 and 3.57), independence of errors (Durbin-Watson value of 1.95), and shows variance and approximately normally distributed errors and residuals, but a slight heteroscedasticity due to the ordinal nature of the data. The results should thus be taken with care (confirming our initial choice for non-parametric tests).

2.3. A targeted literature review

A final supplemental method was a comprehensive review of the academic literature published in the past ten years on the topic of EVs and social acceptance globally. To help frame our hypotheses, and also better ground our results within the literature, we searched for studies (looking at any country, region, or city) published with the words “electric mobility,” “mobility,” “electric vehicle,” “carbon,” “travel” and “transport” in the titles, abstract, and keywords of full length articles alongside the words “income,” “class,” “equity,” “politics,” “political affiliation,” “geography,” “urban,” “rural,” and “culture.” Although not meant to be a systematic review, meaning results were not formally coded, nor was formal content analysis conducted, we collected approximately 50 studies to examine, most of which are cited throughout the article.

3. Income and classism in electric mobility

3.1. Previous global literature

A growing stream of research has emphasized the connection between income and mobility patterns, including electric mobility. For if it is true, as Fainstein (2010) has written, that a just city demands diversity, democracy, and equity, then systems of mobility provision must also take into account disparities in income. Sager (2006) adds that mobility cuts to the heart of different types of social justice or freedom: some of it is positive, such as the freedom to move or be motile, known as “freedom to;” others aspects are negative, such as the things we want to avoid (pollution, unaffordable transport schemes), and can thus be framed as “freedom from.” Both types of freedom can be impacted by EVs. Wells (2012) suggests that “mobility, or the lack thereof, has long been recognized as an important aspect of exclusion, inequality and poverty.” Upham et al. (2015) add that “there are significant, income-based differences for transport practice.” Sovacool et al. (2019: 205) write that “electric mobility can erode elements of distributive justice for being accessible only to the rich,” and contravene other elements of justice by “reinforcing exclusion and elitism in national planning.” Here, we summarize four distinct threads of scholarship: that car ownership rates rise with income, that transport related greenhouse gas emissions rise with income, that preferences for electric vehicles are correlated with higher incomes, and that patterns of adoption (so far) tend to favor wealthier households.

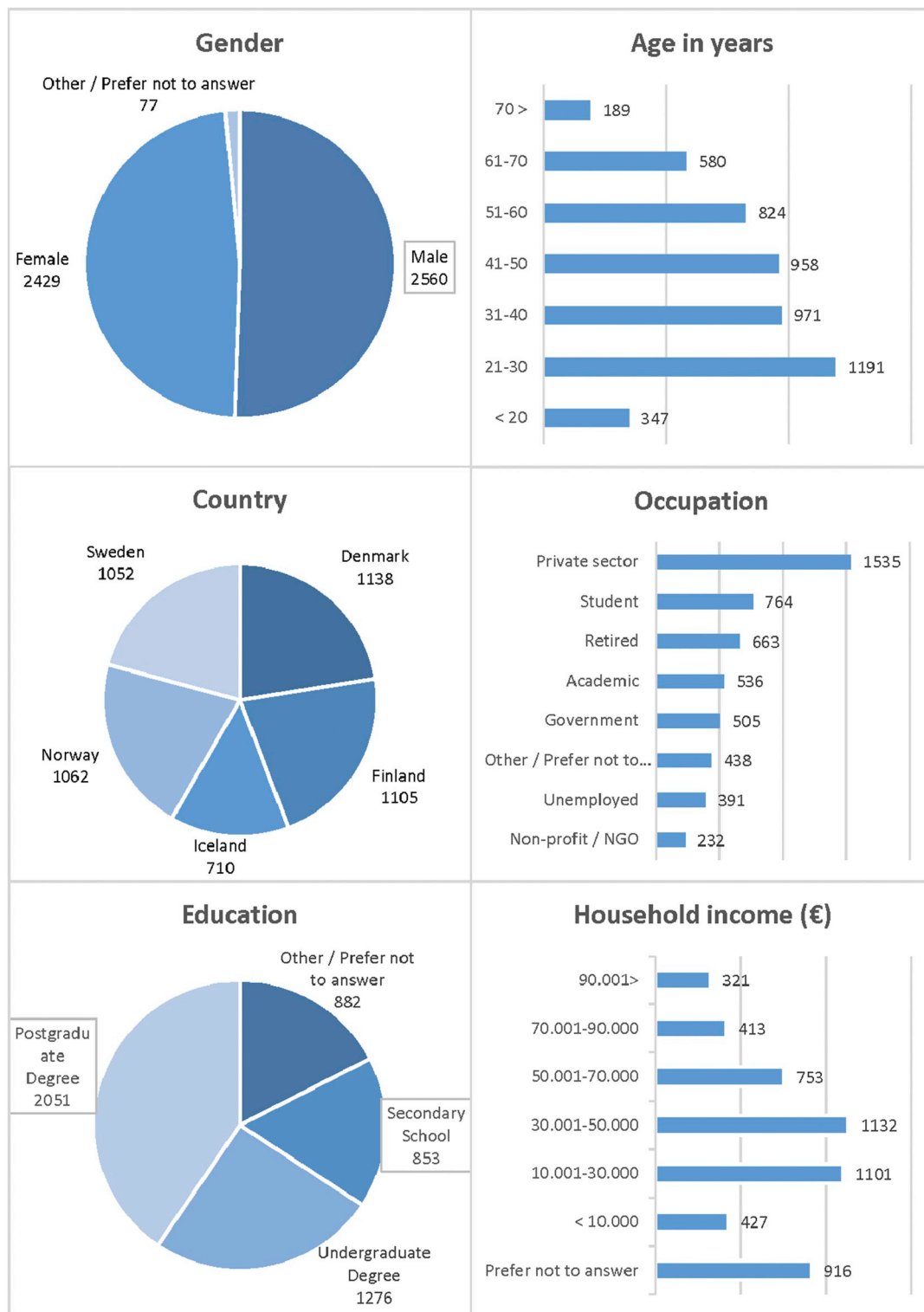


Fig. 1. Demographic characteristics of our Nordic EV survey sample.
(Source: Authors)

First, research has suggested that car ownership, and related factors such as kilometers travelled, and expenditures on transport, increases with income across the globe. In Brazil, increasing demand for mobility rises substantially with increasing income (Manfred et al., 2006). In Finland, vehicle ownership increases significantly with income along with vehicle usage, whereas use of public transport, such as train, bus, and metro, and walking decline (Upham et al., 2015). In the United

Kingdom, those in the highest income quintile travel nearly three times further than those in the lowest quintile (Banister and Anable, 2009). Moreover, transportation infrastructure and technology developments often benefit middle and upper class denizens because they cater to their transportation needs through the development of suburban highways, for instance; and poorer residents or communities are more likely to be displaced or have their neighborhoods disrupted due to

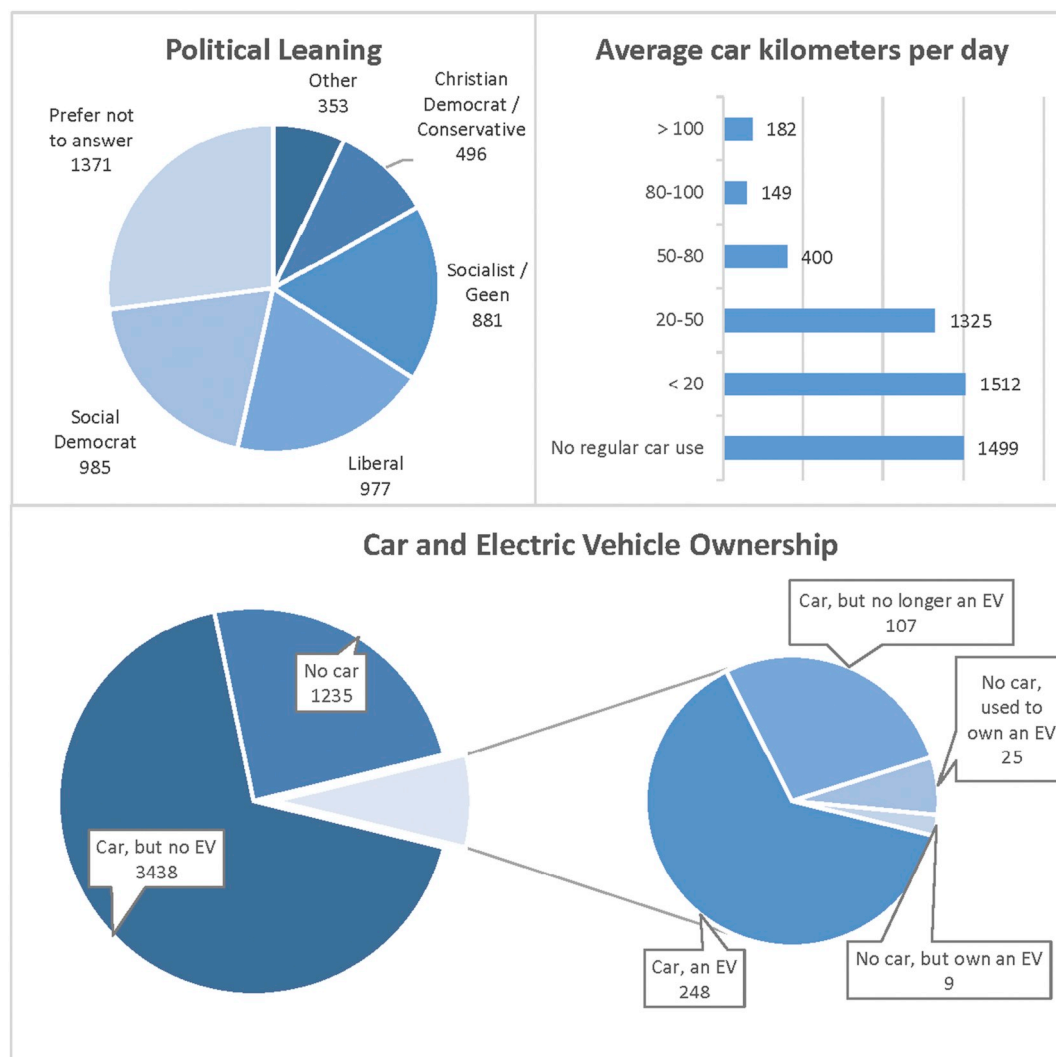


Fig. 1. (continued)

developments (Roth, 2004; Kaufmann and Jemelin, 2003).

A second focus of research has been on the association between transport related energy use, and greenhouse gas emissions, and income. In the United Kingdom, for example, transport related carbon dioxide emissions rise almost proportionally to income, and far more than other aspects of consumption: a 1% increase in income relates to a 0.60% increase of transport emissions, but only 0.19% of home energy emissions (Büchs et al., 2013). A global assessment of the energy and transport emissions profiles of twelve major metropolitan areas—Beijing, Jakarta, London, Los Angeles, Manila, Mexico City, New Delhi, New York, Sao Paulo, Seoul, Singapore, and Tokyo—noted that “cities in our sample with the lowest per capita carbon footprints are located in countries with low per capita incomes,” and that ten of the cities displayed “a nearly perfect monotonic relationship between carbon footprints and per capita national income” (Sovacool and Brown, 2010: 4865). The relationship to income and emissions was even significant in those cities that promoted walking, cycling, and efficient public transportation.

A third research focus has been on stated preferences or intentions related to electric vehicles and income. In France and Germany, EV purchasing intentions increase with a higher level of income, with a higher number of cars in the household and increases in daily mileage travelled (Ensslen et al., 2015). In Ireland, McCoy and Lyons (2014: 91) note “low income agents will be income constrained regardless of their environmental preferences; higher income more able to express

environmental preferences.” A stated preference survey conducted in the United Kingdom revealed that higher income groups are more likely to consider a PEV as a second vehicle (Skippon and Garwood, 2011), a finding confirmed by Noel et al. (2019a) in the Nordic region. In some cultures such as Northern Europe (Noel et al., 2019b) or China, EVs are perceived as an elite and luxury consumer technology (Tyfield et al., 2014), although this is not always the case – another Chinese survey noted that individuals from higher-income households preferred gasoline cars to electric ones (Yang et al., 2017).

A fourth strand of research reports on actual adoption patterns in emerging electric vehicle markets. As Wells (2017: 751) writes, “only if an individual is wealthy enough to own or run an electric vehicle, or is afforded one by the company that employs them, can that individual then benefit from the many financial incentives available to assist the purchase.” Early adopters of plug-in EVs in Austria therefore tend to be both wealthy and older than ordinary drivers (Wolf and Seebauer, 2014). In Sweden, current electric vehicle owners belong “to the rather higher end” of earners compared to the normal population (Vassileva and Campillo, 2017). In Canada, “pioneer” adopters of electric vehicles tend to have “significantly higher income” than mainstream car buyers (Axsen et al., 2016). In Norway, the first movers and early adopters have tended to be high-income households using electric vehicles as a second car (Nilsson and Nykvist, 2016), similar to adopters in the United States (Neubauer et al., 2012).

Table 2
Differences in EV and car use and preferences about vehicle attributes by levels of income.

Dimension	Income ^a
<i>Car use^b</i>	
Car ownership	It is well known that car ownership is associated to income and our positive correlation ($r_s = 0.251$) is unsurprising. In fact, in our sample 48.7% of those earning less than €10,000 own a car compared to 90.3% of those earning over €90,000 a year. Likewise, the mean number of cars increases from 0.82 to 1.74. This association extends to all five countries.
Km per day	Km travelled extends to daily car travel, which too is associated and correlated to income ($r_s = 0.250$) with 27.4% of those earning over €90,000 driving > 50 km a day compared to 19.7% of those earning between €50,000 and €70,000 and 8% of those earning less than €10,000 a year. This association returns in the individual countries, except for Iceland ($p = .013$).
EV experience	EV driving experience is similarly associated and correlated to income ($r_s = 0.196$), with 15% of those under €10,000 state they have experience driving an EV compared to 22% of those earning between €30,000 and €50,000, 32.4% of those earning between €70,000 and €90,000 and 41.7% of those earning more than €90,000. This association extends to the countries except for Iceland (not significant and invalid test).
EV ownership	EV ownership is associated to income level with another positive correlation ($r_s = 0.132$) as 13.7% of those earning over €90,000 own an EV compared to 2.3% of those earning between €10,001 and €30,000. Interestingly, after recoding into a binary never owned an EV and have or currently owning an EV, this association is slightly less significant in Denmark ($p = .009$, $r_s = 0.086$) and in Norway ($p = .004$, $r_s = 0.127$), but returns in Finland ($p < .001$, $r_s = 0.144$) and Sweden ($p < .001$, $r_s = 0.138$). It also returns in Iceland, but with an invalid test ($p = .001$, $r_s = 0.158$).
EV interest	The EV interest of non-EV owners is also associated and correlated ($r_s = 0.136$) to income. Around 55% of the people in the groups earning under €10,000 and up to €30,000 answered somewhat interested and very interested, a figure that hovers around 62.5% for those earning between €30,000 and €90,000 and then rises to 70.3% for those earning over €90,000. This association does not extend to Iceland (invalid $p = .641$, $r_s = 0.138$) and Norway ($p = .062$, $r_s = 0.138$), but can be found in Finland ($p < .001$, $r_s = 0.149$) Sweden ($p < .001$, $r_s = 0.184$) and Denmark ($p < .001$, $r_s = 0.142$). Interestingly, this is because Iceland is characterized by high levels of interest across all income groups, and Norway similarly has a flatter distribution of interest.
Expected purchase price of next car	The expected costs of a new car are also associated and definitely correlated to the level of income ($r_s = 0.313$). In the group earning over €90,000, 54.4% expects to buy a car over €30,000 compared to a still surprising 6.8% for those earning less than €10,000 a year. This association extends to each of the countries.
<i>Car preferences^c</i>	
Design and engineering: speed/acceleration, size/comfort, design/style, ease of operation	Only <i>ease of operation</i> shows no variance across income groups. <i>Speed and Acceleration</i> is significant, with an increasing mean rank per income group and in particularly the low mean rank of the €10,000 to €30,000 income group versus the €70,000 and up groups. <i>Size and comfort</i> is answered similarly different with an increasing mean rank per income group, and with an exceptional high mean rank for those earning over €90,000 a year. <i>Design and style</i> sees a similar increase in mean rank, but also a drop for the less than €10,000 income group, in line with students and younger age groups.
Costs and Impacts: Technical reliability, safety, fuel economy/financial savings, price, environmental impact	Income shows variance on all but <i>environmental impact</i> , which is answered more or less equally across income levels. The importance of <i>technical reliability</i> increases with income, but does so in groups with less than €10,000 scoring lowest, €10,001 to €70,000 all scoring more or less equally in the middle, and over €70,000 scoring highest. <i>Safety</i> ($p = .035$) shows variance but not for independent pairs, due to high overall mean ranks that only slightly increase for €70,000 and up. <i>Fuel economy and financial savings</i> sees a relative high mean rank for the lower income groups that drops after €50,000 a year. <i>Price</i> equals <i>fuel savings</i> in that the mean rank is even higher for the low income groups and drops a median across the board after €50,000 to a relatively low mean rank for the €90,000 group.
EV preferences: range, battery life, public charging, charging time, V2G	Income groups think differently on three of the five questions on electric vehicles. The two where they agree on are <i>public charging</i> and <i>charging time</i> . When it comes to <i>EV range</i> the under €10,000 income groups scores this a median lower than the rest, with a peak importance for the €70,000 to €90,000 group. For <i>battery life</i> ($p = .045$) the mean rank is more or less equal with a slight bell curve for the middle income groups. There are no independent pairs however. Lastly, for <i>V2G capacity</i> we see relative high mean ranks for the first three income groups which lowers after €50,000, to a drop in median for the greater than €90,000 group.

^a All results are $p < .001$, except where indicated.

^b Chi-Square test, percentages are column based (not row or total sample).

^c Independent Sample Kruskal-Wallis test.

3.2. Nordic findings

The findings derived from our survey deepen those previously mentioned in the literature. Our results, summarized in Table 2, suggest

that income is clearly relevant. Higher income levels are associated with car ownership, the number of cars owned by higher income households' increases, as does the percentage of longer distances travelled per day. Regarding EVs, it is also the higher the income, the

Table 3
Differences in EV and car use and preferences about vehicle attributes by political orientation.

Dimension	Political orientation ^a
<i>Car use^b</i>	
Car ownership	Car ownership is associated to political inclination, with a 63.3% ownership rate on the left among those who identify themselves as socialist and/or green and 86.5% among Christian democrats and conservatives. This association extends to the countries with the exception of Iceland where car ownership is high across the political orientations.
Km per day	This association returns for daily car travel, with 10.4% of the socialist and green driving over 50 km a day and 42.1% driving only rarely, compared to 20.6% of conservatives driving over 50 km a day and only 17.5% driving only rarely. Liberals follow closely with 18.8% and 22.3% respectively. While social democrats and the other category can be found just above the socialist and green voters with 13.6%–13.8% and 27.2% - 29.7% respectively. Within the countries this association returns, with Denmark ($p = .001$), and with the exception of Iceland.
EV experience	EV driving experience is similarly associated to political orientation with 28.2% of the liberals claiming to have experience driving and EV, followed by 25% of the conservatives and around 22% of the left, social democrats and “other” category. Within the countries EV experience and political orientation are associated for Denmark, Finland, and Sweden ($p = .003$), but not as significant for Norway ($p = .046$) and Iceland (invalid).
EV ownership	EV ownership is associated to political orientation but distributed differently with an equal uptake between socialist/greens (6.7%) and liberals (6.6%), closely followed by Christian democrats/conservatives (6.3%), social democrats (5%) and the “other” group (3.7%) with the lowest rate for those who preferred not to answer (2.9%). After recoding to never owned an EV and owned or owning an EV, this association extends to Iceland (with a 30.3% peak for Christian democrats and conservatives) and Denmark ($p = .002$), with higher scores for socialists and greens and social democrats, but does not extend to Finland, Norway or Sweden. This indicates that in those countries political orientation is less connected to EV ownership.
EV interest	The EV interest of non-EV owners is also associated to political orientation and is highest for socialist and greens (72.8%), about 60% for social democrats and liberals, and lowest for Christian democrats and conservatives with 52.9% answering <i>somewhat interested</i> or <i>very interested</i> (lower than the “other” group that could not find themselves in our categories). This association extends to each of the countries, indicating that political leaning impacts level of interest in EVs.
Expected purchase price of next car	The expected costs of a new car are associated to political orientation. Christian democrats and conservatives and liberals are most often expecting to pay over €30,000 (29.6% and 28.3%), while those declining to answer and the socialist / greens do so least (15.7% and 17% respectively). The other group and social democrats sit in the middle, but more on the low side (20.3% and 19.3%). After recoding to four categories (less than €10,000, €10,001 to €20,000, €20,001 to €30,000, and above €30,000) this association returns within Denmark ($p = .001$), Finland, and Sweden ($p = .002$), but not to Iceland and Norway.
<i>Car preferences^c</i>	
Design and engineering: speed/acceleration, size/comfort, design/style, ease of operation	Only <i>ease of operation</i> shows no variance across political orientations. <i>Speed and acceleration</i> sees quite some variance, especially between the low mean rank of the socialists and greens compared to the highest mean rank of the liberals. The importance seems to rise with more right positions. <i>Size and comfort</i> sees a similar difference between socialists and greens and liberals as does <i>Design and style</i> . In both cases the liberals are closely followed by the Christian democrats and conservatives and social democrats.
Costs and impacts: technical reliability, safety, fuel economy/financial savings, price, environmental impact	Regarding costs and impacts, political orientation shows significant variance for all five questions. For <i>technical reliability</i> the variances stem from the low mean rank of those disinclined to answer, but not from any other differences between pairs of orientations. For <i>safety</i> the variance originates in the relatively low scores by Christian democrats / conservatives and liberals compared to the socialists / greens and social democrats. <i>Fuel economy and financial savings</i> is witness to a drop in median for the conservatives and liberals especially compared to the socialists / greens, and the social democrats to a lesser extent. The distribution of <i>price</i> ($p = .007$) is mainly driven by the low mean rank and drop in median from the conservatives versus the high score of those on the left of the political spectrum. Lastly, the variance in importance attributed to <i>environmental impact</i> of a car stems from the rather extreme (in our sample) difference between the high mean rank of the socialists / green score and the likewise extreme low score of the conservatives ($U = 130,407.5$, $n = 1376$, $z = -13.219$, $p < .001$, $r = 0.356$). Those who declined to answer or categorized themselves as “other” or liberal all scored more or less equal, with the social democrats scoring a bit higher, but nowhere near the socialists / greens.
EV preferences: range, battery life, public charging, charging time, V2G	Political orientation shows variance for all but <i>public charging and charging time battery life</i> and <i>charging time</i> . The mean rank of <i>EV Range</i> shows a difference between the high mean rank of liberals (closely followed by conservatives) and those on the left and not willing to answer. <i>Battery life</i> ($p = .022$) shows variance, but not for independent pairs after correction. Lastly, <i>V2G capacity</i> ($p = .050$) shows a drop in median for the group identifying themselves as other, especially compared to the highest mean rank of the social democrats. Although the latter is closely followed by the other political orientations.

^a All results are $p < .001$, except where indicated.

^b Chi-Square test, percentages are column based (not row or total sample).

^c Independent Sample Kruskal-Wallis test.

higher the percentage that has (1) experienced them, (2) is interested in them, and (3) – as important – owns them. At the same time, higher income groups demand more from their cars and are willing/able to pay for that. In a way, none of these results are surprising and they confirm the importance of price as a core barrier when buying electric vehicles, at least for high-end models such as Tesla or the Nissan Leaf (perhaps less so for cheaper options such as the I-MiEV, Buddy, or Th!nk). Simultaneously, our results show that in time lower income groups, who are interested in EVs nonetheless, could be served with lower priced and less demanding electric vehicles (e.g. less range, smaller batteries, less weight, less costly).

4. Politics and political identity in electric vehicle preferences

4.1. Previous global literature

Unlike income, less research has explored the topic of politics and electric vehicle diffusion, with most work looking only at somewhat peripheral elements such as car use, political discourse, and environmental values related to climate change.

For instance, one survey in Germany confirmed that those with stronger ecological norms and a liberal identity, mostly women, were more willing to reduce car use, to use public transport, and to change their habits (Matthies et al., 2002). Northern European populations—notably Germany, Denmark, and Norway—are also seen to promote a strong environmental ethic politically that can be reflected in national political parties and policies (Bigerna et al., 2017). Denmark in particular was one of the first countries to move towards a comprehensive use of environmental taxes and Ecological Tax Reform (Klok et al., 2006). Comparative studies of attitudes have also found that Danes are more politically attuned to environmental and sustainable energy issues (Kilbourne et al., 2002; Manfred et al., 2006; Stilianos et al., 2013) and that they regard climate change as a more serious problem deserving of national policy attention (Mills and Schleich, 2012), leading to stronger support for low-carbon technologies (Sovacool and Blyth, 2015) or low-carbon forms of mobility such as hydrogen and ridesharing (Nielsen et al., 2015). Then again, Denmark is also one of the only countries to remove earlier introduced EV benefits (Noel and Sovacool, 2016).

Another theme of work has emphasized the discursive elements of EVs, and how they may attempt to capture the social imagination of voters, or become salient political symbols. Ryghaug and Toftaker (2016) for example document an underlying visionary and predictable dimension to EV politics in Norway. Such politics are visionary in that political deliberation can capture public desires and national imaginaries about mobility, but they are predictable in that these tend to be highly scripted. Imagined futures of electric mobility are thus not necessarily radical or transformative in terms of challenging automobility. Similarly, Bergman et al. (2017) and Bergman (2017) criticize the politics and discussions of EV scenarios and futures in the UK for being too conservative, for framing EVs as supporting technological progress for incumbents and having rather constrained views of consumer behavior in an automobility dependent society.

The only other stream of scholarship touching on politics relates to climate change and the motivations to address it. In the United States, political orientation is “so strong” that it moderates the influence of other key factors predicting climate change views such as education, scientific literacy and self-reported understanding; whether one is a Democrat or a Republican has a more significant influence (McCright et al., 2016). Oddly, political views in the United States are so deterministic in shaping climate attitudes that they have a stronger effect than even weather events (Marquart-Pyatt et al., 2014). Work has also confirmed that conservatives are less likely to support climate action than liberals in Australia and the United Kingdom (Unsworth and Fielding, 2014). Hess and Renner (2019) similarly suggest that political orientation, as reflected in party positions and key documents, will

influence views on things like low-carbon technologies or the phasing out of fossil fuels, although the study notes that views are often complex and dynamic within as well as across conservative parties.

4.2. Nordic findings

Political orientation returns in our sample as a significant variable. While the political systems in the Nordic countries look quite alike (from the outside), the systems and political landscapes are in fact different. To cope we decided to offer only four main categories, which we felt were representative even though for instance socialist and greens are clearly not an easy mix. To compensate we actively include the “other” category in our analysis as the category where people have grouped themselves from a mix of political orientations ranging from hybrid parties, extreme right, and solely green.

Table 3 summarizes how current car ownership seems highest among conservatives and Christian Democrats closely followed by those with a liberal orientation. These groups are also able/willing to pay more for cars and seem to have more EV experience. At the same time, non-EV owning conservatives in our sample are least interested in electric vehicles and actual EV ownership is more equally distributed across political orientations. When it comes to car preferences there is an even clearer divide between political orientations with the left deeming design and engineering aspects lower than the right, while they deem costs and impacts more important than the right – exemplified by the large difference in the stated importance of the environmental impact of cars. When it comes to EVs, range is more important to those on the right, while all orientations more or less agree on the importance of charging related issues.

5. Geography, space, and urbanism in electric vehicle diffusion

5.1. Previous global literature

This final category of research emphasizes the geographic and spatial dimensions of EVs, tying into debates about the spatiality of mobility, and how such conceptions of space touch upon the relationship between human beings, the natural environment, and technology (Kellerman, 2011, 2012). In this sense, mobility and electric mobility is always relational, always multi-scalar, for “one kind of mobility seems to always involve another mobility; motility is never singular but always plural” (Adey, 2006: 18).

Thus, this body of evidence advances the notion that support for electric vehicles will differ by political regimes, geographies, and economic conditions, thus varying across countries (Kilbourne et al., 2002). This is not only due to variation in socioeconomic or demographic variables across space—but also variations in access to energy (and mobility) services, geographical conditions and climate, population density, and consumer lifestyles (Manfred et al., 2006). As Upham et al. (2015: 217) write, “Dependence on differing transport modes and a wider variety of differences between ... locations may affect attitudes to innovation policy options in ways that are difficult to anticipate.” At least two factors are at play in this concern, urban versus rural diversity, and spatial variation for reasons of culture, regulation, or morphology.

One stream of research emphasizes a divide between urban and rural locations. For instance, urbanity can have a negative influence on energy requirements and consumption footprints (Manfred et al., 2006). Increasing commuting distances from both suburban and rural areas can also lead to dependency on private automobiles (Choudhury et al., 2015). Frequency of use of mass transit is also correlated with the size of urban areas, with more populated municipalities having better (i.e., more equitable or affordable) access to public transport (Abenaza et al., 2017). In the United Kingdom, living in a rural place is still significantly associated with higher emissions even after controlling for income, and the strongest effect is for transport emissions, which are

Table 4
Geographic policy variation for electric vehicles, 2008 to 2014.

Country	Role of government (policy approach)	Economic interest (turnover car industry/GDP)	Diffusion aspiration (PEV target) 2020	EV diffusion (% of total) vehicle stock
Canada	Hands-off	7.4%	3.5%	0.04%
Denmark	Enabling facilitator	0.5%	1.8%	0.13%
France	Interventionist director	5.7%	6.0%	0.13%
Germany	Enabling facilitator	8.9%	2.4%	0.06%
Italy	Interventionist director	3.3%	1.8%	0.01%
Japan	Enabling facilitator	10.6%	3.3%	0.17%
Netherlands	Enabling facilitator	0.5%	2.3%	0.50%
Norway	Enabling facilitator	2.8%	6.7%	1.46%
Portugal	Interventionist director	2.5%	10.5%	0.05%
Spain	Interventionist director	7.2%	10.5%	0.05%
Sweden	Enabling facilitator	7.1%	12.5%	0.17%
United Kingdom	Hands-off	2.7%	4.6%	0.08%
United States	Hands-off	3.6%	4.9%	0.26%

Source: Adapted from Wesseling (2016). Note GDP = Gross Domestic Product. EV = Plug-in Electric Vehicle.

16% higher for rural than for urban households (Büchs et al., 2013). Concerning electric mobility in particular, urban areas often see lower levels of “range anxiety” since potential adopters may consider electric vehicles well suited for urban areas (Rezvani et al., 2015). Urban areas are also where it can be easier to deploy public charging infrastructure (Nilsson and Nykvist, 2016).

Another stream of research emphasizes more obtuse factors at play that can create variation in mobility patterns or preferences: density, land morphology, policy, and culture. King et al. (2017: 1250) argue that “mobility through physical travel is strongly determined by geographic factors and their interdependence with transport and service infrastructure, transport policies and economic factor. Some geographic settings foster a high dependence on car travel principally due to a mix of low-density housing; low levels of public transport provision; location of businesses, services and shops away from most residential areas; and affordable motor vehicles.” For instance, incentives for electric vehicles differ drastically in intensity and orientation among countries (Kester et al., 2018), ranging from those supporting innovation on the supply side to those encouraging adoption or financing on the demand side (Wesseling, 2016). Table 4 for instance shows three distinct regulatory environments for electric vehicles across thirteen countries. Such “geographical diversity” can create differing arrays of policy mixes and national contexts that can shape particular diffusion patterns for electric vehicles (and other alternatives) (Raven et al., 2017).

Other studies have noted “notable variation” in interest in electric vehicle adoption across major cities in the United States (Carley et al., 2013). Geography can also be a proxy for culture, or at least cultural variation, differences in prevailing value and belief systems that can explain purchasing behavior (Pettifor et al., 2017a). Cultural differences across Europe can account for preferences for the design features of vehicles, including size and power (de Mooij and Hofstede, 2002). Culture can also mediate social influences on vehicle choices, with consumers in the United States more susceptible to appeals rooted in status and materialism, whereas consumers in China may be more susceptible to appeals rooted in community wellbeing and longer-term gain (Pettifor et al., 2017b).

5.2. Nordic findings

Our results indicate that across the countries there are quite some differences in car use and car preferences. In some cases, as Table 5 reveals, these differences reflect existing market conditions: the relative low car prices in Sweden, the relative high-income level in Norway, the low-income level in Finland, the clearly felt fossil fuel dependency in Iceland, and the strong Norwegian and Icelandic EV incentives and market uptake. Iceland offers a rather unique case, with its extremely high car ownership, relatively low distances travelled per day, high interest in EVs and overall higher mean ranks for most of the car attributes – especially for environmental impact, fuel efficiency/financial savings, and safety. In turn, Finland stands out with its price focus, low EV experience and ownership rates, and relative low mean ranks on the other questions, including or in particularly for environmental impact of cars (a result shared with Norway, interestingly). It is also telling that EV range is ranked relatively highest in Norway and Iceland, countries where cities are rather isolated urbanized centers with long and difficult geography between them (and high domestic airplane use).

Also, besides their country of residence we asked our sample whether they would consider themselves living in a rural ($n = 963$), suburban ($n = 2298$) or urban environment ($n = 1801$). In our sample, illustrated in Table 6, those who claim to live in a rural area have a relative higher car ownership rate and EV ownership rate than those living in (sub)urban regions. They also drive longer distances – which might explain their higher ranking of EV range. Additionally, they prefer V2G over the other regions. This pattern does not extend to EV interest however, which is highest in urban environments. In these urban regions respondents also score public charging highest and show the highest concern for environmental impacts. In turn, suburban inhabitants score the importance of public charging relatively low, while giving greater importance to the size and comfort of a car. It is also in suburban regions that EVs are most popular in Norway, which contrasts with the dominating rural rates in Denmark and Sweden. Interestingly, EV experience seems not to be related to the region where one lives, indicating that rural conditions are less of a hindrance to gaining driving experience.

Table 5
Differences in EV and car use and preferences about vehicle attributes among the countries

a) Top panel: narrative results	
Dimension	Country ^a
Car use ^b	
Car Ownership	Car ownership is associated to the countries, with an extreme 87.9% car ownership rate in Iceland and between 70.9% (Finland) and 75.4% (Norway) in the other countries.
Km per day	Daily car travel is associated to the countries with Iceland having the lowest percentage of persons driving rarely (11.4%), and most often between 0 and 50 km a day (72.1%). Norwegians also mainly drive shorter distances (60.2%) with only 10.0% driving > 50 km a day. Danes most often drive > 50 km a day (18.2%). Otherwise, on average between 29.6% and 34.9% drive only rarely, between 50.5% and 56% drive under 50 km a day, and between 13.4% and 16.5% of our sample drive over 50 km a day.
EV experience	EV driving experience is associated to the countries. Well in line with current EV market conditions the highest percentage of EV experience can be found in Norway – but still only 32% of our sample. This is closely followed by Iceland (25.9%), then Sweden (20.5%), Denmark (19.9%) and lastly Finland (14.8%).
EV ownership	EV ownership is similarly associated to the countries ($p = .001$). Norway leads with 7.3% of our sample of Norwegians, followed by Sweden (5.6%), Iceland (5.5%), Denmark (4.0%) and Finland (3.3%).
EV interest	EV interest of non-EV owners is also associated to countries, which becomes even clearer after recoding to those showing interest and those not showing interest. In Iceland EV interest is highest, with 75.9% answering that they are <i>somewhat</i> or <i>very interested</i> . Then comes Norway (56.7%), Finland (54.8%), Sweden (53.9%) and lastly Denmark (53.7%). Counterintuitively, the highest percentage share of people <i>very uninterested</i> can be found in Norway (14.9%).
Expected purchase price of next car	The expected costs of a new car are also associated to countries, which makes sense given Sweden's low car taxation and domestic car industry and Finland's general economics (especially compared to Norway). Finland stands out particularly with only 15.5% expecting to pay over €30,000 for a new car compared to 16.9% in Sweden, 18.2% in Iceland, 22.2% in Denmark and 31.3% in Norway. This is reflected in the percentages of those expecting to pay less than €20,000, which is highest in Finland (65.3%), closely followed by Sweden (62.4%), Iceland (56.2%), Denmark (50.6%) and Norway (43.2%).
Car preferences ^c	
Design and engineering: speed/acceleration, size/comfort, design/style, ease of operation	All four are answered differently across the countries. For <i>speed and acceleration</i> ($p = .004$) the variance is most obvious between the high mean rank for Iceland compared to the low ranks for Finland and Denmark. For <i>size and comfort</i> we again see a strong increase in mean rank (and a jump in median) for Iceland, compared to the other countries and especially the lowest mean rank of Finland. <i>Design and style</i> ($p = .008$) is favored highest in Norway compared to Denmark and Finland. Lastly, the mean rank of <i>ease of operation</i> is highest in Iceland again compared to all the other countries.

(continued on next page)

Table 5 (continued)

a) Top panel: narrative results		Country ^a				
Dimension						
Costs and impacts: technical reliability, safety, fuel economy/ financial savings, price, environmental impact						
EV preferences: range, battery life, public charging, charging time, V2G						
When it comes to electric vehicles, the countries differ in mean rank for all but the presence of V2G capacity. The mean rank of <i>EV Range</i> is lowest for Finland and highest for Iceland (followed by Norway), even though the latter primarily drives short distances. The mean rank for <i>battery life</i> resembles <i>range</i> in that Iceland has the highest mean rank and Finland the lowest, with Norway behind Iceland and Sweden, and Denmark above Finland. <i>Public charging</i> also sees the highest mean rank for Iceland, but no variance between the other countries. Lastly, the mean ranks for <i>charging time</i> differ primarily between the high mean rank of Iceland and the lower ranks of Norway, Denmark and Finland, with Sweden to be found in between.						
b) Bottom panel: summary statistics; mean importance per country						
	Denmark	Finland	Iceland	Norway	Sweden	Overall
Speed and acceleration	3.44	3.46	3.62	3.51	3.52	3.50
Size and comfort	4.17	4.13	4.40	4.24	4.21	4.22
Design and style	3.60	3.63	3.69	3.75	3.64	3.66
Ease of operation	4.06	4.15	4.29	4.09	4.09	4.12
Technical reliability	4.25	4.34	4.42	4.30	4.29	4.31
Safety	4.55	4.52	4.72	4.59	4.57	4.58
Fuel economy and financial savings	4.34	4.26	4.58	4.29	4.34	4.35
Price	4.34	4.42	4.46	4.34	4.39	4.38
Environmental impact	3.88	3.77	4.10	3.78	3.94	3.88
EV range	4.31	4.27	4.56	4.44	4.30	4.36
EV battery life	4.53	4.52	4.78	4.65	4.56	4.59
EV public chargers	4.43	4.47	4.63	4.42	4.46	4.47
EV charging time	4.27	4.30	4.48	4.33	4.35	4.33
EV V2G Capacity	3.62	3.59	3.62	3.56	3.64	3.60

^a All results are p < .001, except where indicated.^b Chi-Square test, percentages are collum based (not row or total sample)

Table 6
Differences in EV and car use and preferences about vehicle attributes by levels of urbanization

a) Top panel: narrative data	
Dimension	Living area ^a
Car use ^b	
Car ownership	Car ownership is associated to level of urbanization, with an inverse relationship between rates of ownership and level of urbanization ($r_s = -0.156$). 82.7% of those in rural areas own a car versus 65.8% of those living in an urban environment.
Km per day	This relationship extends to daily car travel, which is also associated and correlated to geography ($r_s = -0.176$). 39.4% of those living in an urban region only rarely drive a car, versus 21.5% of those in rural areas. Inverse, 20.7% of the rural habitants need to drive over 50 km a day, compared to 10.7% of urban dwellers.
EV experience	EV driving experience is neither associated ($p = .036$) nor correlated to the living areas, as stated EV experience hovers between 20.6% and 24.2%. This extends to all 5 countries.
EV ownership	EV ownership is associated to the region where one lives ($p = .001$), with a very weak negative correlation ($r_s = -0.060$) as 6.9% of the rural inhabitants own an EV compared to 5.4% of the suburban and 3.6% of the urban inhabitants. Interestingly, this figure seems to be driven by Denmark and Sweden where respectively 9.5% and 8.8% of rural inhabitants drive an EV while in Norway 8.8% of suburban inhabitants drive an EV and only 5.5% of those living rurally. To be complete, urbanization and EV ownership are only associated in Denmark.
EV interest (non-EV owners)	EV interest of non-EV owners is also associated to one's geography ($p = .004$), which becomes even clearer after recoding to those showing interest and those not showing interest. In contrast to EV ownership, however, the correlation is positive but just as weak ($r_s = 0.064$) and interest is highest among those living in urban environments (61.8%), followed by suburban environments (56.1%) and lowest in rural environments (53.6%). Simultaneously, this association only returns in Norway ($p = .002$) with 64.2% of the urban and 50.5% of rural inhabitants showing interest. In the other countries this association does not return strong enough, as interest is more equally distributed over level of urbanization.
Expected purchase price of next car	The expected costs of a new car are not associated or correlated to the region where one lives. With perhaps 4% point ranges between the lowest and highest, an average of 22% is willing to pay under €10,000, 33% is willing to pay between €10,000 and €20,000, 24% is willing to pay between €20,000 and €30,000, and around 21% is willing to pay > 30,000€. In fact, only in Sweden ($p = .005$) do we find an association between living area and expected purchase price, with those in urban areas expecting to buy more expensive cars.
Car preferences ^c	
Design and engineering: speed/acceleration, size/comfort, design/style, ease of operation	Of these, only <i>size and comfort</i> is answered somewhat differently ($p = .016$) given a difference between the low score for urbanites and the highest score of suburban inhabitants. The others have more or less equal mean ranks, implying that people find them equally important no matter their level of urbanization. Within the countries, these variances do not return. Only Iceland shows variance for <i>speed and acceleration</i> ($p = .016$) with a low mean urban rank, and for <i>size and comfort</i> ($p = .006$) with a low mean urban rank.
Costs and impacts: technical reliability, safety, fuel economy/financial savings, price, environmental impact	Regarding costs and impacts, living environment has no difference for <i>safety, fuel economy and financial savings, or price</i> . For <i>technical reliability</i> ($p = .047$) the low mean rank and drop in median (to 4) for the suburban sample stands out but cannot be confirmed after correction for a specific pair. <i>Environmental impact</i> ($p = .013$) does show a significant pair with those living in urban environments ranking this higher than those in suburban environments. Within the countries only Norway shows any variance, specifically on <i>environmental impact</i> ($p = .044$) but also without a specific pair.
EV preferences: range, battery life, public charging, charging time, V2G	When it comes to electric vehicles, the geographic typologies differ in mean rank for all but the importance of <i>battery life and charging time</i> . The mean rank of <i>EV Range</i> ($p = .008$) shows a stark difference between those in rural areas and those in suburban or urban areas. <i>Public charging</i> scores low for those in suburban regions, especially compared to those living in an urban environment (apartment building charging problems?). Lastly, living area is one of the few variables whereby people rank <i>V2G capacity</i> significantly different ($p = .03$) as especially rural inhabitants rank this higher compared to those living in urban regions. Within the countries there are no variances, except in Denmark for <i>public charging</i> ($p = .034$) given the higher urban mean rank versus the suburban rank, in Finland for <i>V2G capacity</i> ($p = .039$) between suburban and the higher mean rank of rural, and in Iceland for <i>charging time</i> ($p = .001$) and <i>V2G capacity</i> ($p = .007$) with low suburban and urban scores compared to the rural score.

b) Bottom panel: summary statistics (mean importance ranking per country)

	Rural	Suburban	Urban
Speed and acceleration	3.55	3.51	3.46
Size and comfort	4.24	4.24	4.17
Design and style	3.65	3.65	3.67
Ease of operation	4.12	4.13	4.12
Technical reliability	4.34	4.29	4.33
Safety	4.61	4.58	4.57
Fuel economy and financial savings	4.37	4.33	4.35
Price	4.41	4.38	4.38
Environmental impact	3.88	3.85	3.92
EV range	4.43	4.35	4.34
EV battery life	4.63	4.60	4.58
EV public chargers	4.48	4.45	4.49
EV charging time	4.36	4.33	4.32
EV V2G capacity	3.68	3.61	3.56

^a All results are $p < .001$, except where indicated.^b Chi-Square test, percentages are column based (not row or total sample).^c Independent Sample Kruskal-Wallis test.

Table 7

Hierarchical regression analysis controlling for country location, urbanization, political orientation, and income (N = 2906).

	M1 (β)	M2 (β)	M3 (β)	M4 (β)	M5 (β)
<i>Model 1: control</i>					
Gender (F = 1)	−0.035	−0.042*	−0.041*	−0.057**	−0.051**
Age	−0.166***	−0.138***	−0.132***	−0.120***	−0.132***
<i>Model 2: countries</i>					
Denmark		−0.025	−0.028	−0.042	−0.039
Finland		−0.010	−0.012	−0.020	−0.003
Iceland		0.131***	0.133***	0.125***	0.128***
Sweden		0.002	−0.001	−0.001	0.016
<i>Model 3: urbanization</i>					
Rural			−0.047*	−0.042*	−0.043*
Suburban			−0.063**	−0.054**	−0.056**
<i>Model 4: political orientation</i>					
Other				−0.041*	−0.033
Socialist/green				0.104***	0.115***
Social democrat				−0.012	−0.003
CD/conservative				−0.047*	−0.047*
<i>Model 5: income</i>					
Under €10,000					−0.105***
€10,001–€30,000					−0.146***
€30,001–€50,000					−0.104**
€50,001–€70,000					−0.060*
€70,000–€90,000					−0.039
R ²	0.026	0.045	0.049	0.067	0.076
ΔR^2	0.026	0.019	0.004	0.018	0.009
ΔF	39.18***	14.28***	5.62**	13.81***	5.90***

All ‘prefer not to say’ and missing answers have been excluded listwise and reference groups for dummies are: Men, Norway, Urban, Liberals, and Income over €90,000.

* (p < .05).

** (p < .01).

*** (p < .000)

6. Interaction effects and hierarchical regression model results

The final step in our study was to conduct a hierarchical regression analysis to observe the relative interactions among geography, urbanization, political orientation and income towards the level of EV interest among non-EV owners. The results are shown in Table 7.

Revealingly, these combined results show that political orientation, geography, urbanization and income explain about 7.6% of the variation in EV interest. Positively inclined are Icelanders and Socialist/Greens, negatively inclined are lower income groups, women, higher age groups, suburbanites and Christian Democrats/conservatives. In general, after age and gender, nationality (e.g. EV market conditions) and political orientation (e.g. social and environmental awareness) seem a bit stronger linked to EV interest than urbanization and, surprisingly, income which showed high bivariate correlations to vehicle and EV ownership but explains < 1% of variance in EV interest. That, however, is a limit of EV interest as dependent variable (Zarazua de Rubens, 2019). The bivariate analyses showed that there was a discrepancy in our sample between EV interest (more urban, sustainably inclined) and actual EV use (absolute numbers favouring suburbs, but relatively high rates claiming to live rurally). The model thus confirms many of the earlier bivariate interactions and adds the relative value of each of our key focus variables.

7. Conclusion

Our results both confirm some of the findings from the previous literature on income, politics, and geography around vehicle and EV ownership and preferences but also introduce some challenges and difficult questions. With this in mind, we offer three conclusions.

First, in terms of income, while our findings confirm that EV ownership and mobility patterns in our sample are related to income—those with higher incomes both own more EVs and drive more generally—they also confirm that *interest* in EVs, while significant, is not so strongly related. This is primary mediated by shared levels of interest in

Iceland and Norway across income groups, with our Norwegian sample interestingly showing the highest relative number of *very uninterested* participants. This may be a result of the success of EVs in Norway, making previously uninterested individuals, now very uninterested, polarising the market more significantly vs. a country like Denmark where adopters are < 1% market share. As important, lower income groups in our sample seem to ask less from their cars, thus potentially opening up a market for cheaper low range EVs in addition to more expensive EVs with longer ranges. This affirms earlier work that has discussed how EVs are items of “conspicuous consumption” or luxury (Noel et al., 2019) for some, but have mass-market appeal due to their ease of operation or affordability according to other frames of functional or environmental performance (Sovacool and Axsen, 2018). They are thus “hybrid constructions” (Anfinssen et al., 2019) that can contain competing and contested narratives about what EVs can accomplish, and for whom. We also confirm in our sample that those with higher income levels, through increased average daily kilometers in the car, also have higher transport related emissions, introducing a pesky question for policy: does that mean the affluent should be the focus of decarbonisation efforts in transport, or would targeting them only further increase the gap in travel demand between classes?

Second, our sample confirms that political orientation is correlated to car and EV ownership, with those on the liberal “left” more interested in EVs and with a relatively high EV ownership rate but overall lower car ownership levels. This contrasts with findings that the conservative “right” are more able and willing to buy expensive cars, including EVs as given by the shared percentage and high absolute number of EVs owned by Liberals in our sample, who simultaneously show lower interest in EVs than the Socialists/Greens. This shows EVs have been politicized, in the same manner as renewable energy (and others), which may be a result of the initial deployment strategy of focusing primarily on the environmental benefits of EV. Motivations for EV adoption may change as we move to mass adoption, with a strategy that places more focus on the status and technological elements of EVs (Zarazua de Rubens, 2019; Noel et al., 2019).

Initially we attributed this to the fact that income is more determinant than political identity in shaping and molding preferences. For instance, our sample shows a positive correlation between increasing income scales and more rightwing orientations (r_s 0.140, $p < .000$). Yet, Section 6 showed that this does not hold towards EV interest among our sample. More inquiry is needed on this point, but, at the very least, it shows once more that principles or motivations to purchase and ability to buy are two different things. This offers a potentially sobering criticism of studies seeking to reveal the willingness to pay or adopt an EV, a large set of the literature in behavioral economics and environmental psychology, since there is an implicit assumption that people's self reported attitudes match their later behavior or lifestyle.

Third, in terms of geography, our findings confirm both variation across the five Nordic countries in terms of preferences, but also that EVs need not be “only for Norway,” the current global market leader. In our sample, car preferences across the countries are quite alike, with small variations in importance, but an overall similar trend of answers to our preference questions (with the exception of Iceland). Counter to our finding above about income and political orientation, we also note that EV taxation benefits are not just for the rich, as Norway and Iceland with their strong taxation benefits also seem to have EV ownership distributed more equally over income groups – although the relationship is still positively correlated, and EV interest seems less impacted by income and taxation policies. We see variation in preferences across urban and rural subcategories as well, with urban respondents valuing battery life and availability of public chargers more, and rural respondents valuing range and charging times more. Furthermore, in our sample our self-proclaimed rurals stated to own relatively more EVs than in the other groups, but as a group rurals simultaneously showed less interest in EVs. More critically, our findings suggest that EVs need not be promoted only for city or suburban areas—in fact, a case can be made that EVs should actively be promoted in rural areas first, especially with positive preferences among our sample's rural residents consistently reported across all five countries and data showcasing relative high rural rates of adoption in Denmark and Sweden.

These findings demand that we rethink national and well as local policy targeting EVs and V2G systems in the Nordic Region. The heterogeneity and variety across demographic groups by income, politics, and space implies that single policy instruments such as taxes or subsidies, presumed to work uniformly and fairly across all audiences, will be less effective than those targeting distinct subgroups. Moreover, it strongly suggests that class, political orientation, and country of origin may mediate patterns of mobility more broadly and/or mediate perceptions of other emerging innovations such as shared mobility or automated mobility. Income, political affiliation, and spatiality (geographic location) are clearly influential factors in explaining why people may embrace, or reject, attempts at decarbonizing transport via electric mobility.

Acknowledgments

The authors are appreciative to the Research Councils United Kingdom (RCUK) Energy Program Grant EP/K011790/1 “Center on Innovation and Energy Demand,” the Danish Council for Independent Research (DFF) Sapere Aude Grant 4182-00033B “Societal Implications of a Vehicle-to-Grid Transition in Northern Europe,” which have supported elements of the work reported here. Wokje Abrahamse from the Victoria University of Wellington in New Zealand, and Abigail Martin from the University of Sussex, graciously offered suggestions for how to conduct and interpret our hierarchical regression analysis. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of RCUK Energy Program and the DFF.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jtrangeo.2019.06.006>.

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